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SLOPE STABILITY OF THE NANTICOKE LONG-TERM FLY ASH STORAGE MOUND

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A groundwater monitoring program was carried out at the Nanticoke long-term fly ash storage mound in 1990. With the monitored results, slope stability analyses were performed. This report describes the monitoring program, reports the field data and presents the findings of the slope stability calculations.

1.0 INTRODUCTION

In the early 1990s, the coal fly ash produced by the Nanticoke TGS was sluiced to a 76-ha (182-acre) disposal lagoon on the north side of the generating station. During this period, the ash discharged into the lagoon and formed a soft deposit on the bottom surface of the lagoon. Following field trials in 1981, a new ash management system was used to increase the storage capacity of the lagoon. In this new system, shown in Figure 1, the fly ash/water slurry is routed through a primary settling cell, a secondary settling cell, then the primary and secondary lagoons, before the effluent leaves the disposal site. As most of the fly ash particles settle out in the primary cells, these cells are cleaned out by draglines on a regular basis. The dredged ash is hauled to another area within the original lagoon clay-dyke perimeter and is stacked to form a long-term storage mound. Since the new ash management system was adopted at the lagoon site, in the early 1980s, several engineering problems are required to be dealt with. One problem pertains to the stability of the long-term fly ash mound. Because the fly ash produced at the Nanticoke station is basically a cohesionless material, the stability of the side slope of the mound formed by the ash is sensitive to the pore water pressures within the mound/1/. As it is difficult to estimate the pore water pressure in the ash due to the continuous ash

stacking process, a field monitoring program was undertaken to measure the water pressure within the ash mound. This report presents results of field monitoring and slope stability calculations.

2.0 INSTALLATION OF PIEZOMETERS AND MONITORING DATA

In 1990, a total of 17 piezometers were installed along several slope sections of the existing fly ash mound. The piezometers were installed by first augering holes in the ash. Then PCV pipes, with the bottom section perforated and wrapped around with a filter fibre, were placed in the holes. Sand was placed around the 1-m perforated pipe section and the remaining part of the space between the unperforated pipe section and the borehole wall was backfilled with fly ash.

The locations of the piezometers are shown in Figures 2 and 3. No piezometers were installed on section B-B due to on-going construction activities around that area. It is planned to install piezometers at that location in the future.

Water levels in the piezometers were measured in October and December 1990, and the results are summarized in Table I. Between these two sets of measurements, about a 1 m increase in piezometric head was observed in piezometers A1 and A2. This change could have been caused by the water level fluctuations at the primary lagoon.

3.0 SLOPE STABILITY ANALYSES

On the basis of the December 1990 piezometric data, slope stability analyses were done to calculate the safety factor of four slope sections. The results, summarized in Figures 4 to 7 and Table II, show that no slope instability is anticipated provided that the water level within the ash mound is similar to what was measured in 1990. The safety factor for section C-C, where the as-built setback distance is 7.6 m (25 ft) instead of the 24.4 m (80 ft) as suggested in the original Civil Design drawing/1/, is 1.26. For this critical section, a further slope stability analysis was carried out with the assumption that the estimated maximum phreatic surface as at elevation 203.3 m (Figure 8). The calculated safety factor was about 1.2, which indicates a stable slope condition.

4.0 SUMMARY AND RECOMMENDATIONS

A monitoring program was undertaken to measure the groundwater pressure within the long-term fly ash storage mound at the Nanticoke TGS. The water table in the ash mound was low probably due to a reasonably good drainage towards the primary lagoon and the secondary lagoon, as well as seepage from the side slope surfaces. Based on the monitoring groundwater data, slope stability analyses of the ash mound were carried out. It has been found that the slope with the maximum design crest elevation of 218.2 m is stable (ie factor of safety > 1), provided that the long-term groundwater level would be comparable to that presently observed inside the mound. Since the stability of the ash mound strongly depends on the groundwater condition within the mound, a continuing monitoring of the groundwater level at the site is recommended to ensure the safety of the existing ash mound.

During our field visits to the ash storage mound in 1990, it was observed that there was much water in the temporary ash placement cells. Ponding in these cells may increase the groundwater level within the ash mound. Therefore, it is recommended that the bottom surface of each of the placement cells be properly graded so that the free ponding water can drain to a sump and be pumped out from the cells.

The long-term position of the groundwater level in the ash mound will depend on the cover system to be placed on the mound at the final close-out stage. Staff members of the Civil Research Department are presently engaged in a comprehensive study on the design, analysis and performance of various cover systems. Some of the findings have been presented in Ontario Hydro Research Division reports/2,3/. The results from the ongoing laboratory and field studies will be published in 1991.

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1. K.C. Lau and H.T. Chan. The Study of a Water Table Within a Fly Ash Mound at Nanticoke. Ontario Hydro Research Division Report No 89-39-K. March 22, 1989.

2. H.T. Chan, A. Vorauer and K.C. Lau. Cover Design for a Fly Ash Landfill Mound: A Case Illustration. Ontario Hydro Research Division Report No 90-273-K. February 6, 1991.

3. H.T. Chan, A. Vorauer and K.C. Lau. Progress Report - Final Cover Research at a Fly Ash Testing Facility, Ontario Hydro Research Division, September 1990.

TABLE I - Summary of Piezometric Readings

NANTICOKE PIEZOMETERS

PIEZOMETER No.	TIP ELEV (FT)	GRD. ELEV (FT)	PIEZOMETRIC HEAD (FT) OCT 17, 90	PIEZOMETRIC HEAD (FT) DEC 14, 90
A1	609.54	628.54	625.31	628.26
A2	618.54	628.54	625.35	628.27
C1	632.58	648.08	643.58	641.43
C2	640.08	648.08	643.62	641.11
C3	622.91	697.91	647.38	647.15
C4	637.91	697.91	648.5	647.81
C5	657.91	697.91	dry	dry
D1	620.14	646.14	645.43	645.46
D2	639.14	646.14	645.42	645.16
D3	621.84	696.84	647.81	647.44
D4	636.84	696.84	648.01	647.58
D5	656.84	696.84	dry	dry
E1	621.53	647.53	640.42	640.95
E2	641.53	647.53	dry	dry
E3	622.2	698.2	642.94	643.6
E4	638.2	698.2	642.89	643.38
E5	658.2	698.2	dry	dry

TABLE II - Results of Slope Stability Analysis

Section	Calculated safety factor
A-A	1.393
B-B	-----
C-C	1.259
D-D	1.602
E-E	1.557
C-C *	1.192

* with maximum phreatic surface elevation at 203.3m.

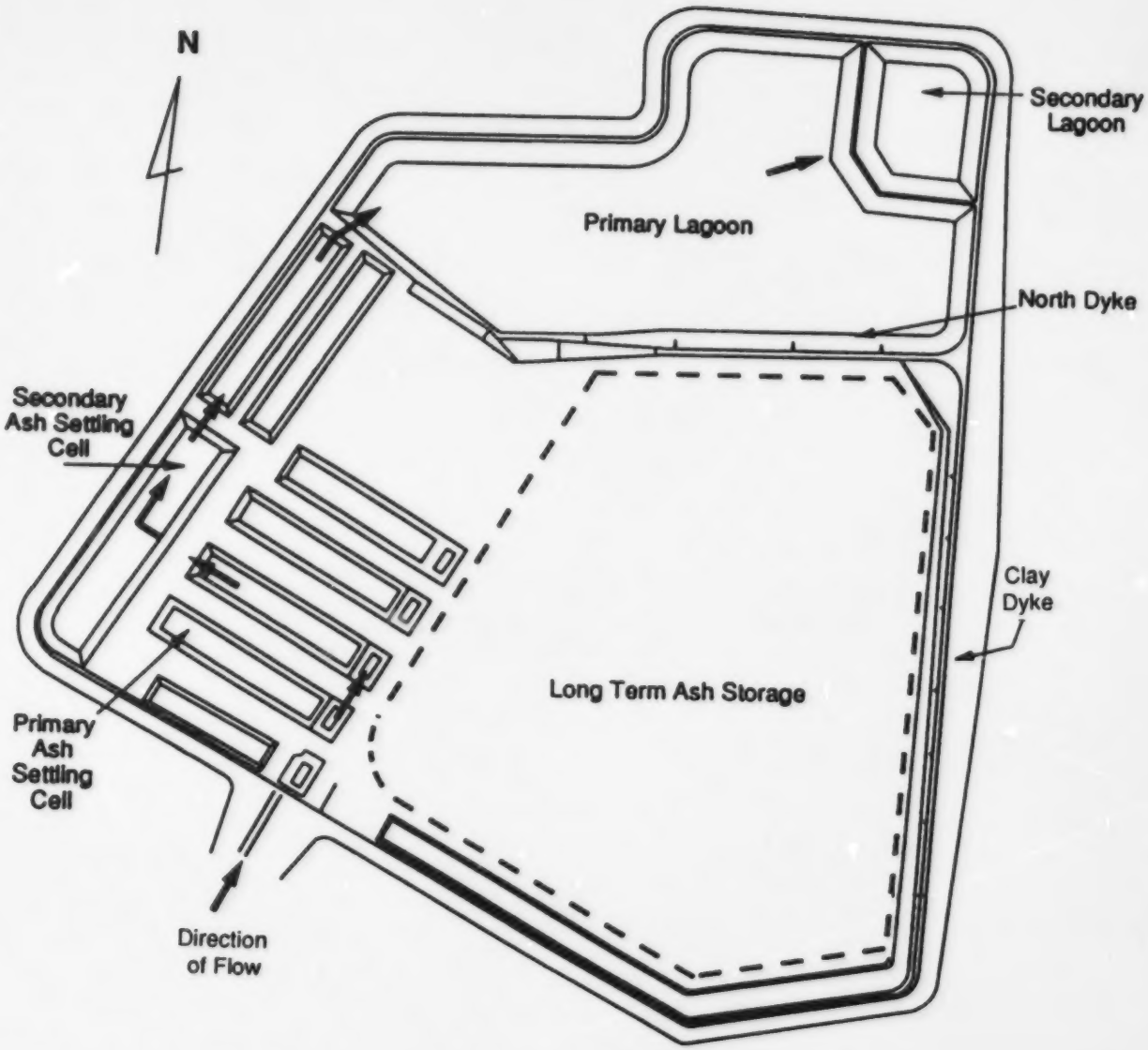

FIGURE 1

PLAN VIEW OF THE EXISTING ASH STORAGE SITE

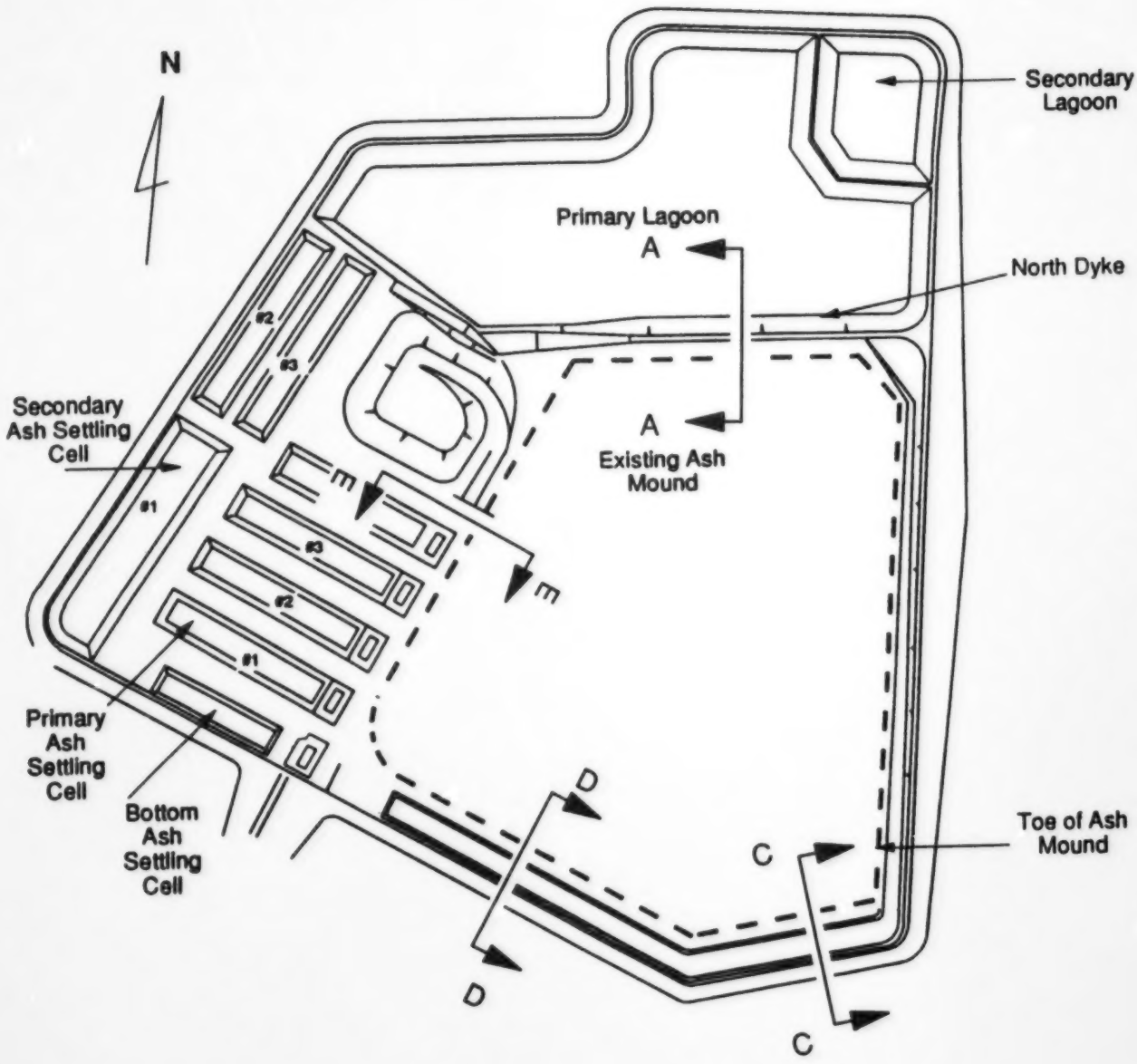

Figure 2 Location of piezometric sections.

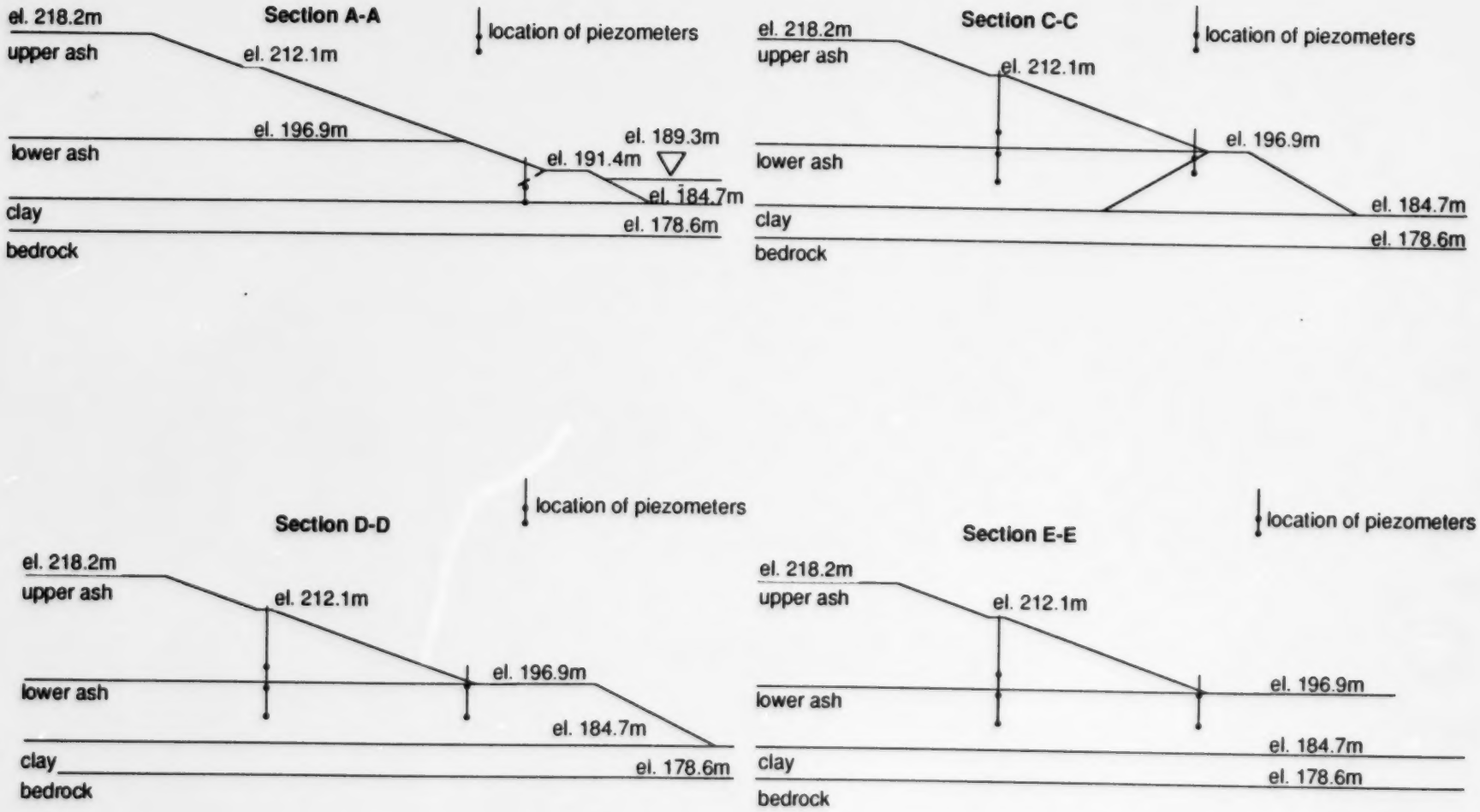

FIGURE 3

LOCATIONS OF PIEZOMETERS INSTALLED IN 1990

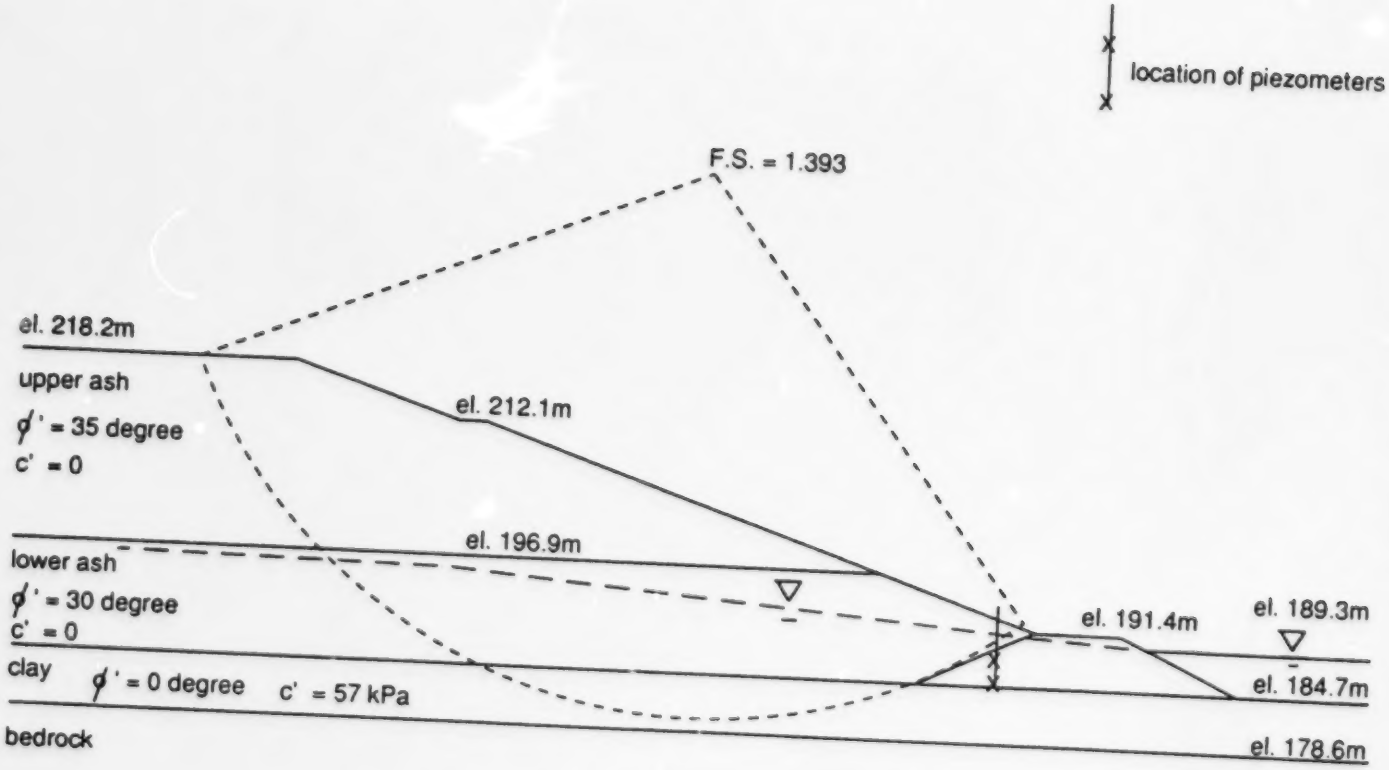

Figure 4 Section A-A.

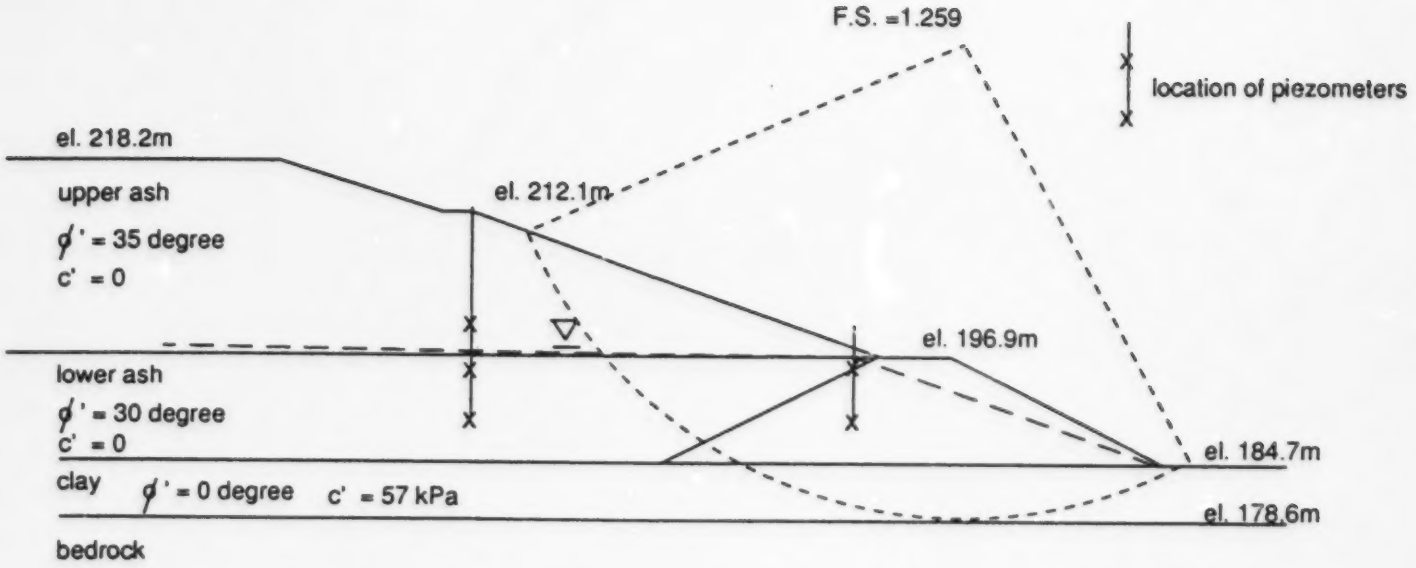

Figure 5 Section C-C.

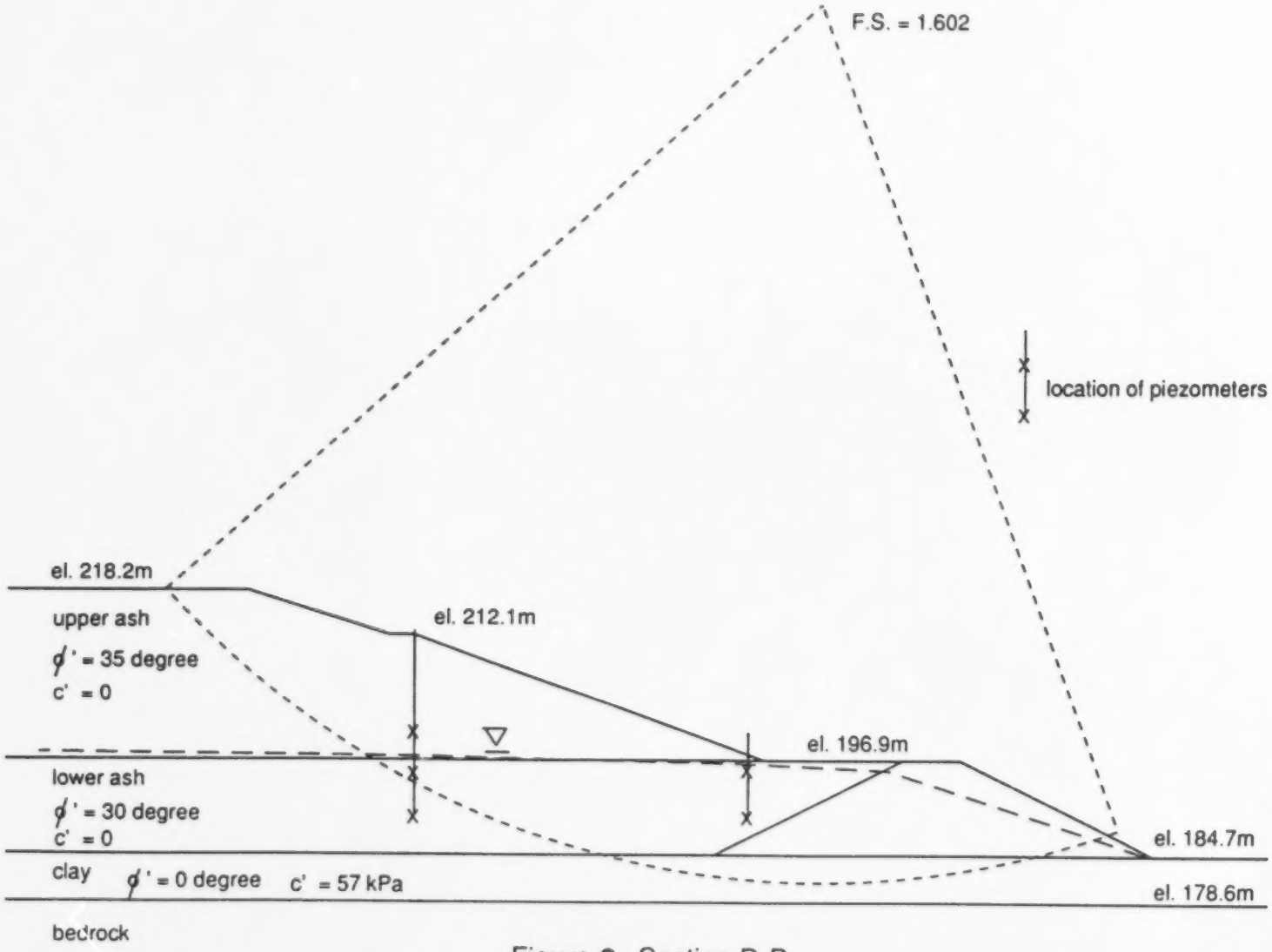

Figure 6 Section D-D.

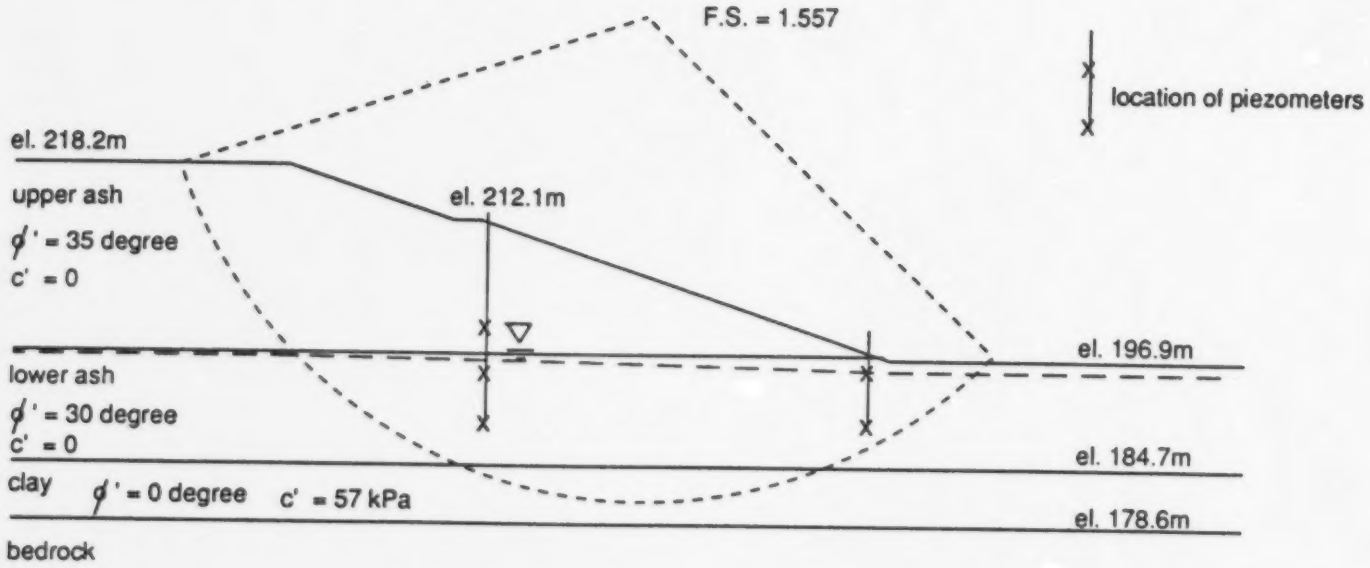

Figure 7 Section E-E.

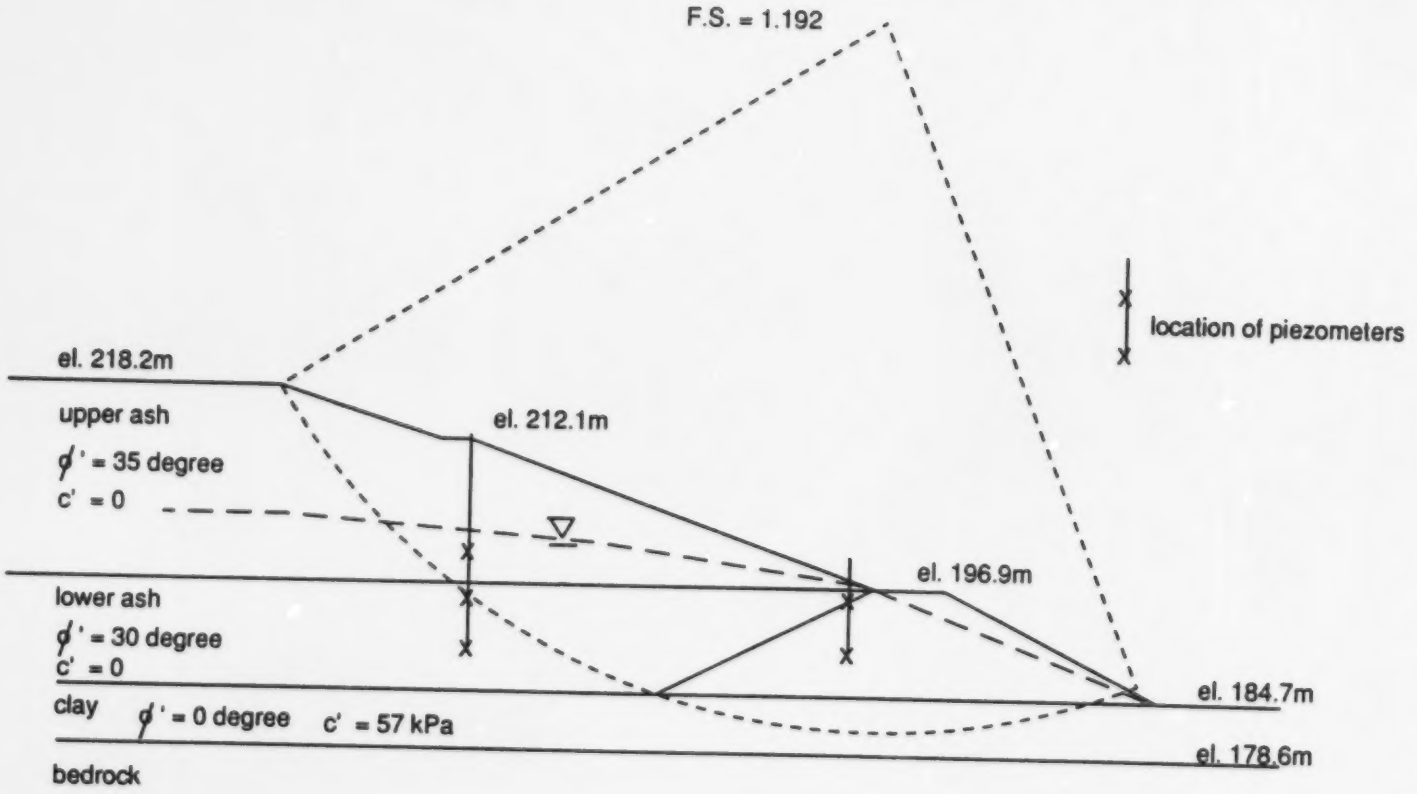

Figure 8 Section C-C with maximum phreatic surface at elevation 203.3 m..